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An Analysis of the Demand for Ontario's Newsprint and Market Pulp in the United States

A. Ghebremichael

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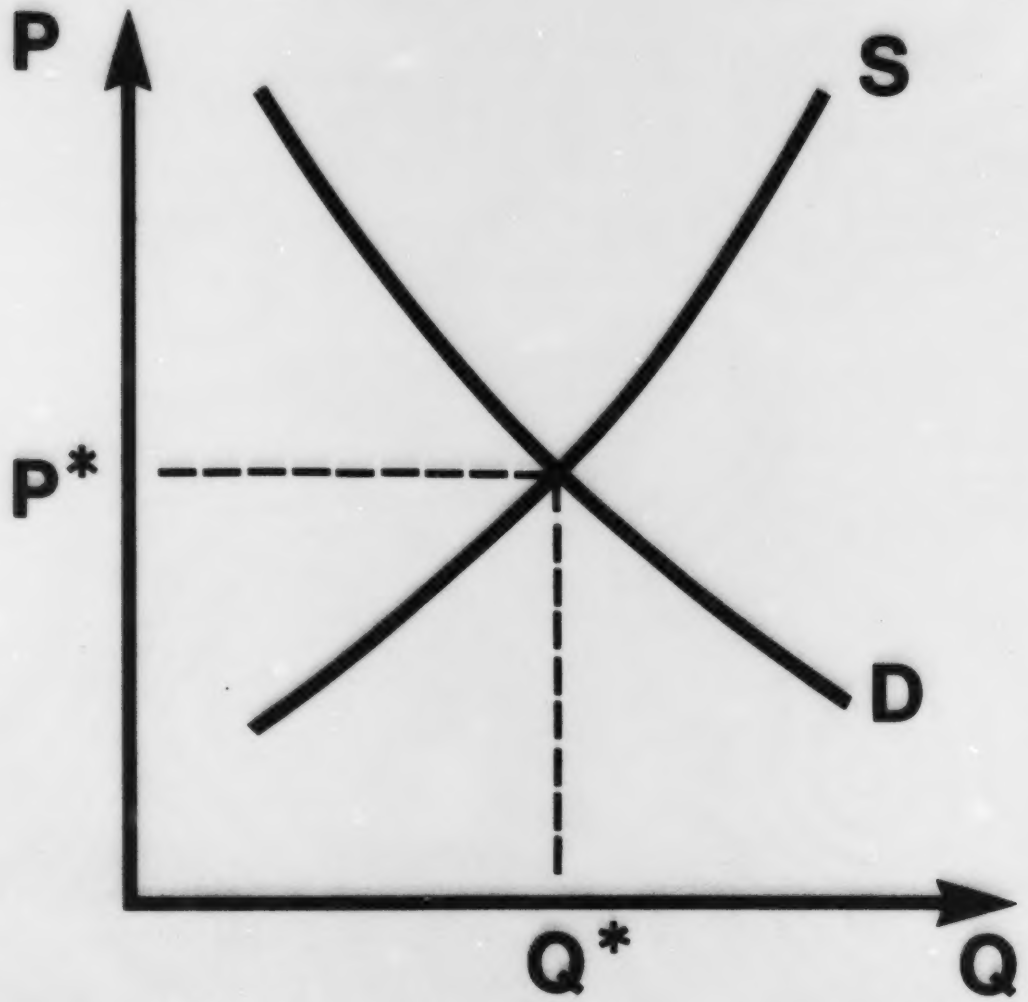
Great Lakes Forestry Centre



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AN ANALYSIS OF THE DEMAND FOR ONTARIO'S NEWSPRINT AND MARKET PULP IN THE UNITED STATES

A. Ghebremichael

GREAT LAKES FORESTRY CENTRE

FORESTRY CANADA

ONTARIO REGION

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ABSTRACT

This study reports the results of an analysis of the demand for Ontario's newsprint and market pulp in the United States over a 21-year period (1966-1986). Past trends in the data were assessed and a "simplified dynamic" model and a static model were used to estimate the demand functions of newsprint and market pulp, respectively.

The annual-average trends indicated that Ontario's newsprint and market pulp exports to the United States increased by 0.80% and 2.73%, respectively, following a 2.53% growth in the American Gross Domestic Product (GDP). Newsprint was found to have an own-price elasticity of -1.45, an income elasticity of 3.95, and cross-price elasticities with respect to writing and printing paper and market pulp of 2.89 and -0.32, respectively. The negative impact of a strong Canadian dollar on the demand for Ontario's newsprint in the American market has been illustrated by an elasticity value of -0.31. The own-price and income elasticities of demand for market pulp were -0.21 and 1.26, respectively.

RÉSUMÉ

La présente étude fait état des résultats d'une analyse de la demande des États-Unis pour le papier journal et la pâte commerciale de l'Ontario pendant une période de 21 ans (1966-1986). Les tendances antérieures des données ont été évaluées et un modèle "dynamique simplifié" et un modèle statique ont été utilisés pour estimer les fonctions de la demande pour le papier journal et la pâte commerciale respectivement.

Les tendances moyennes annuelles ont révélé que les exportations de papier journal et de pâte commerciale de l'Ontario vers les États-Unis ont augmenté respectivement de 0,80 et de 2,73 %, à la suite d'une augmentation du produit national brut américain de 2,53 %. On a découvert que le papier journal avait une élasticité par rapport à son propre prix de -1,45, une élasticité par rapport au revenu de 3,95 et des élasticités croisées par rapport aux prix de papier d'écriture et d'impression et au prix de la pâte commercial de 2,89 et de -0,32 respectivement. L'impact négatif d'un dollar canadien fort sur la demande pour le papier journal de l'Ontario sur le marché américain a été illustré par un coefficient de régression de -0,31. Dans le cas de la pâte commerciale, l'élasticité par rapport à son propre prix et au revenu était de -0,21 et de 1,26 respectivement.

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INTRODUCTION

An Overview

Newsprint and pulp are the most valuable products manufactured by Ontario's pulp and paper industry. This industry is highly market oriented. Johnson (1985) reported that, on average, 95% of Ontario's newsprint and market pulp production is exported, and virtually all of it goes to the United States. Statistical records of Forestry Canada (formerly the Canadian Forestry Service) (Anon. 1987) indicate that earnings from market pulp and newsprint exports to the United States by Ontario producers were $501.2 and $1,139.0 million, respectively, in 1985.

The United States purchases more than half of all Canadian exports and about two-thirds of all Canadian stocks and bonds purchased by foreigners (Wilton and Prescott 1982). The strong economic links between the two countries make the Canadian economy very vulnerable to events in the United States. For example, if the American economy enters a recession, as in 1974 and 1975, or experiences very high interest rates, as in 1980 and 1981, the effects are felt soon afterwards in Canada. The negative impact of such external shocks on the open Canadian economy is significant.

In general, Canadian economic activities are related to economic conditions in the United States. Monetary and fiscal policies of the American government exert considerable influence, particularly on the foreign sector of the Canadian economy. A tight monetary policy, for example, raises interest rates and leads to a decline in the aggregate demand for goods, services, and investment capital by American consumers and investors. Consequently, Canadian exports to the United States decrease. The first export to be affected is usually softwood lumber, which depends heavily on the number of housing construction starts in the United States. The exchange rate between the Canadian and American dollars is another important element that reflects the strong socio-economic ties between the two major trading partners. If the value of the Canadian dollar increases in relation to the American dollar, Canadian goods and services become relatively expensive in the United States. This swing in the exchange rate results in a decrease in Canadian exports.

The United States provides the largest single market in the world for the entire range of forest products, yet Ontario has not exploited its own potential to supply this market other than for newsprint and market pulp (Woodbridge et al. 1987). Markets for newsprint and market pulp in the United States are well established. Ontario firms need to improve their competitive positions through economic efficiency (least-cost combination of inputs) and through development of

aggressive marketing strategies in order to expand their share of the large American market.

The purpose of the present report is to provide an estimate of the demand for Ontario's newsprint and market pulp in the American market. Newsprint and market pulp exported from Canada to the United States are not subject to any trade barriers. However, these two products, like other export commodities, cannot escape the influence of socio-economic policies. The demand for these two commodities in the United States is affected by, among other things: (a) fiscal and monetary policies of both the American and the Canadian governments, (b) the use of substitute products and/or the media (e.g., the use of electronic media rather than newspapers for classified advertisements), (c) economic and population growth rates in the United States, (d) the purchasing power of the Canadian dollar, and (e) the disposable personal income of the American consumer. Although this report uses only a limited number of variables for the empirical analysis, its conclusions take into account a wide range of national and international issues.

The report is organized as follows. First, the literature on previous studies is reviewed. Next, sources of data and past trends in the data during the 21-year period from 1966 to 1986 are dealt with. An attempt is made to relate the pattern of data to national and global issues that describe the social and economic climate that prevailed during this period. The empirical methodology used for this analysis is described in the third section, which also includes a discussion of the theoretical background for the study, and the estimation techniques used. The empirical results are discussed in the next section, along with statistical tests, and a comparison of the empirical results of different studies (including the present one). Finally, the results are summarized and conclusions are drawn. Appendices A through E summarize the laws of demand, review some commonly used single-equation demand models, provide a glossary of frequently used key terms, and present some key analytical statistics on the estimation of demand for newsprint and market pulp, respectively.

Literature Review

This section reviews relevant literature so as to avoid duplication of similar work done by others and to observe the results of other empirical studies carried out by applying a similar methodology.

Although Johnson (1985) described the regional market distribution of newsprint exported from Ontario to the United States, no attempt was made to analyze the impact of different market forces on the quantities of these materials demanded and on the prices charged. Marketplace distribution of products does not provide guidelines for producers developing production and marketing strategies. Demand analysis pro-

vides useful tools for production and marketing managers and for public policy makers.

Studies on demand have been conducted for various commodities, but an extensive search revealed no published information on the demand for Ontario's newsprint and market pulp. More effort seems to have gone into a number of international studies of world demand for paper and paperboard products. For example, Buongiorno (1977, 1978) estimated income and price elasticities in the world demand for paper and paperboard. Uutela (1987) tested the validity of different demand models to estimate these same quantities. With the exception of some data manipulation procedures, the estimation techniques used in these studies are the same. A summary of variables used, time periods covered and the resultant estimates of price and income elasticities of demand for newsprint from various studies is discussed elsewhere in the present report (see **Comparison With Other Studies**).

The Data

The present study covers the period between 1966 and 1986. Numerous sources were consulted to obtain the data. Quantities of newsprint and market pulp exported and their values were provided by the Economics Branch of Forestry Canada. Annual-average exchange rates between the Canadian and American dollars (Cdn$/US$) were obtained from the Bank of Canada. Price indices for newsprint, market pulp, and writing and printing paper were acquired from the Bureau of Labor Statistics of the United States. The Bureau of Economic Analysis of the United States Department of Commerce provided the real Gross Domestic Product (GDP) of the United States as well as various other types of information.

A note on the choice of explanatory variables may be in order at this point. Because specifications of the models are on a **ceteris paribus** basis, it is understood that some important variables, such as changes in the quality of products over time as a result of technological progress and the impact of electronic media, are not assessed. The author hopes to carry out an in-depth study of such factors in the near future.

Past Trends

This section provides a brief overview of the cyclical changes in Ontario's newsprint and market pulp exports to the United States over the 21-year period from 1966 to 1986. Factors that lead to cyclical changes in business and economic time-series include buildups and depletions of inventories, shifts in the rates of capital expenditure by

businesses, year-to-year variations in harvests, and changes in governmental monetary and fiscal policies.

Exports of newsprint and market pulp from Ontario to the United States have fluctuated greatly (Table 1, Fig. 1 and 2). Between 1966 and 1986, yearly growth rates of exports of these products averaged 0.80% (newsprint) and 2.73% (market pulp). The year-by-year information shows tremendous cyclical variations during the 1970s. In 1975, for example, newsprint and market pulp exports dipped by 34% and 22%, repectively. A number of national and international issues need to be analyzed if one is to understand the factors that caused these significant reductions. The major issues of the early 1970s and 1980s include: (i) the 1974-1975 recession in the American economy, when a 1.03% decline in real GDP occurred (Fig. 3); (ii) the 1973-1974 and 1979-1980 worldwide "energy shocks"; (iii) the 1975 Canada-wide labor strike in the pulp and paper industry; (iv) the value of the Canadian dollar in relation to that of the American dollar, which rose by 4.02% from 0.98 in 1974 to 1.02 in 1975; and (v) the decline in the competitive position of Ontario's producers at both the plant and the marketplace levels, mainly as a result of a lack of technological innovation and diffusion (see Table 3-1 in Woodbridge et al. 1987). Exports of both products showed a modest recovery during the short period between 1976 and 1979, with four-year-average growth rates of 11.0% for newsprint and 10.0% for market pulp. However, exports decreased again from 1980 to 1982, with declines of 14.0% for newsprint and 13.0% for market pulp in 1982. It is generally believed that, since the beginning of the 1980s, the downward shift in demand for newsprint is a result of the loss of market share to competing products. Standard newsprint started losing ground to high-quality products, such as rotonewsprint, supercalendered uncoated groundwood, high-brightness grades, and coated groundwood papers. Electronic media also continue to present a challenge to newspapers, thereby placing downward pressure on the demand for newsprint.

Market pulp exports rose by 21.0% in 1983, but dropped by 10.4% in 1985. The rapid cyclical trend in market pulp exports can be attributed to a combination of factors, such as loss of market share by Ontario producers to American producers, who expanded their production capacity, and to other Canadian suppliers (particularly those in British Columbia and Quebec), who took advantage of cost cutting through technological improvement and a relatively cheaper supply of pulpwood. Experts who watch the global market for pulp and paper products provided additional explanations for this situation. In the early 1980s, prices (Table 2, Fig. 4 and 5) of market pulp were affected by: (i) the large quantities of start-up tonnage; (ii) cash-flow pressures that resulted from high interest rates, high ratios of fixed to variable costs, and the weak financial conditions of British Columbia producers; (iii) extreme downward pressure on prices applied by European producers, who used a technique of inventory drawdown to force pulp producers to cut prices; and (iv) the effect of a European Economic Community (EEC) rul-

ing to price a certain number of pulp sales in local currency (see, for example, Anon. [1986]). Although it can be asserted that these issues, which describe a worldwide situation, had negative effects on Ontario's market pulp exports, it is difficult to measure the magnitude of the effect of each factor.

In summary, it is apparent that numerous national and international factors influence the market demand for newsprint and market pulp. It is beyond the scope of a single study to measure the impact of each possible variable. The empirical part of the present study, which begins in the next section, attempts to provide specific measures of the effects of given variables on the demand for newsprint and market pulp exported from Ontario to the United States.

Figure 1: Exports of newsprint and market pulp from Ontario to the United States, 1966-1986.

Table 1. Ontario's newsprint and market pulp exports to the United States, the exchange rate between Canadian and American dollars, and the real GDP of the United States, 1966-1986.

Year	Newsprint[a] (tonnes)	Change[d] (%)	Market pulp[a] (tonnes)	Change[d] (%)	Exchange rate[b] (Cdn$/US$)	Change[d] (%)	Real GDP[c] (1982 prices) ($ billion)	Change[d] (%)
1966	1 594 336	—	659 953	—	1.0773	—	2192.5	—
1967	1 558 493	-2.25	243 889	12.72	1.0787	0.13	2255.0	2.85
1968	1 513 544	-2.88	792 259	6.37	1.0775	-0.11	2347.9	4.12
1969	1 648 469	8.91	877 082	10.85	1.0768	-0.06	2406.2	2.48
1970	1 496 810	-9.20	799 521	-8.84	1.0440	-3.05	2399.1	-0.30
1971	1 420 199	-5.12	766 396	-4.14	1.0098	-3.28	2464.1	2.71
1972	1 427 489	0.51	785 233	2.46	0.9905	-1.91	2584.9	4.90
1973	1 623 402	13.72	803 671	2.35	1.0001	0.97	2711.0	4.91
1974	1 663 394	2.46	820 757	2.13	0.9780	-2.21	2693.5	-0.67
1975	1 104 007	-33.63	637 848	-22.29	1.0173	4.02	2665.7	-1.03
1976	1 295 440	17.34	638 548	0.11	0.9861	-3.07	2793.7	4.80
1977	1 459 295	12.65	826 661	29.46	1.0635	7.85	2921.2	4.56
1978	1 577 118	8.07	786 704	-4.83	1.1402	7.21	3073.0	5.20
1979	1 671 619	5.99	894 468	13.70	1.1715	2.75	3136.6	2.07
1980	1 632 328	-2.35	902 838	0.94	1.1690	-0.21	3131.7	-0.16
1981	1 574 799	-3.52	919 261	1.82	1.1990	2.57	3193.6	1.98
1982	1 359 177	-13.69	804 190	-12.52	1.2341	2.93	3114.8	-2.47
1983	1 511 470	11.20	970 722	20.71	1.2323	-0.14	3231.2	3.74
1984	1 662 933	10.02	999 362	2.95	1.2948	5.06	3457.5	7.00
1985	1 700 455	2.26	895 479	-10.39	1.3652	5.44	3571.5	3.30
1986	1 624 932	-4.44	995 114	11.13	1.3894	1.77	3683.5	3.14
Annual avg. growth	———	0.80	———	2.73	———	1.33	———	2.53

[a] Source: Economics Branch, Forestry Canada.
[b] Source: Bank of Canada, personal communication.
[c] Source: Bureau of Economic Analysis, United States Department of Commerce.
[d] All percentage changes were calculated in relation to the previous year's value.

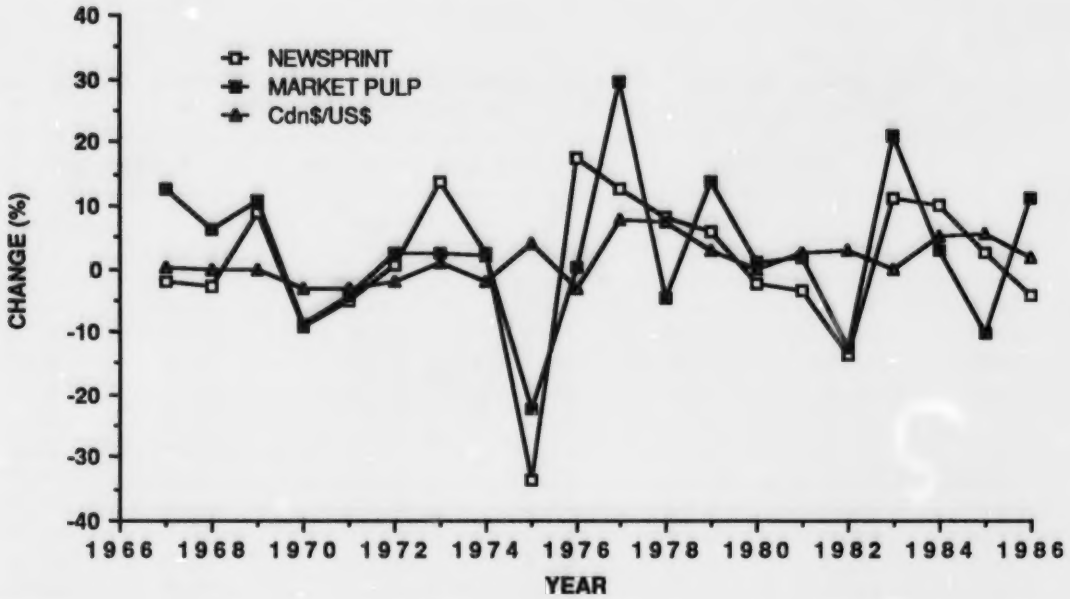

Figure 2: Percent change in newsprint and market pulp exports from Ontario to the United States, and in the exchange rate (Cdn$/US$), 1966-1986.

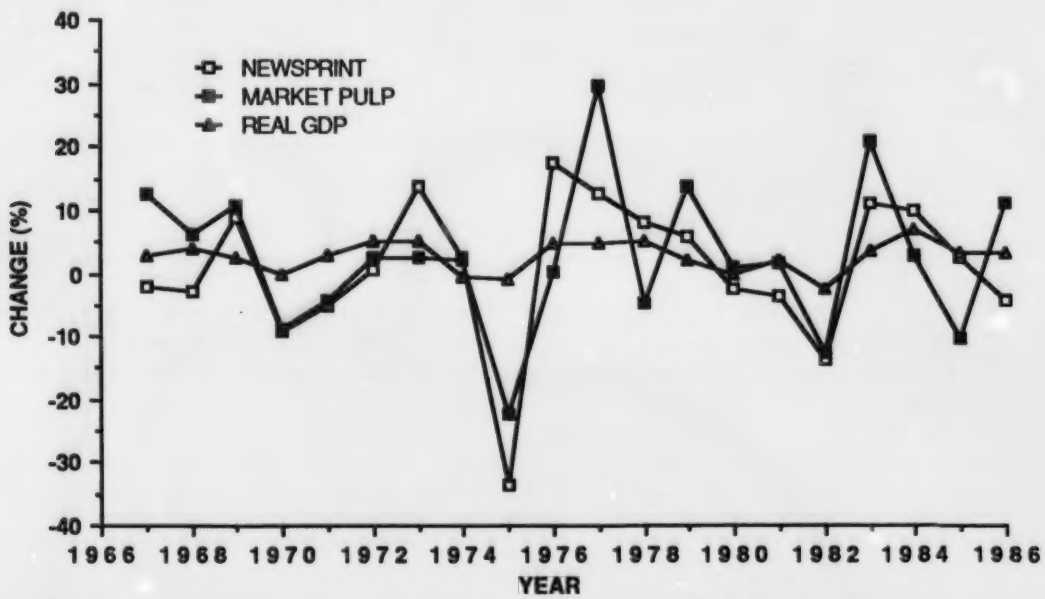

Figure 3: Percent change in American real GDP and in newsprint and market pulp exports from Ontario to the United States, 1966-1986.

Table 2. Price indices[a] of newsprint, writing and printing paper, and market pulp in the American market, 1966-1986.

	Newsprint		Writing and printing		Market pulp	
Year	Index	Change[b] (%)	Index	Change[b] (%)	Index	Change[b] (%)
1966	30.8	----	35.1	----	26.4	----
1967	31.7	2.92	35.9	2.28	26.4	0.00
1968	32.0	0.95	36.7	2.23	26.4	0.00
1969	33.1	3.44	38.0	3.54	26.4	0.00
1970	34.1	3.02	40.2	5.79	28.9	9.47
1971	35.5	4.11	41.3	2.74	29.6	2.42
1972	37.0	4.23	41.7	0.97	29.4	-0.68
1973	38.7	4.59	43.5	4.32	33.8	14.97
1974	47.9	23.77	53.1	22.07	57.5	70.12
1975	58.3	21.71	60.8	14.50	74.8	30.09
1976	62.8	7.72	63.6	4.61	75.5	0.94
1977	68.2	8.60	67.3	5.82	74.2	-1.72
1978	71.7	5.13	71.6	6.39	70.3	-5.26
1979	79.2	10.46	80.0	11.73	82.9	17.92
1980	88.5	11.74	89.6	12.00	100.3	20.99
1981	97.5	10.17	97.4	8.71	104.8	4.49
1982	100.0	2.56	100.0	2.67	100.0	-4.58
1983	95.9	-4.10	99.5	-0.50	91.5	-8.50
1984	102.3	6.67	108.2	8.74	104.8	14.54
1985	105.3	2.93	107.4	-0.74	91.4	-12.79
1986	103.4	-1.90	107.9	0.47	94.7	3.61
Average annual growth:	------	6.44	------	5.92	------	7.80

[a] Source: United States Bureau of Labor Statistics. All prices are relative to 1982 prices, which are assigned a value of 100.

[b] All percentage changes were calculated in relation to previous year's value.

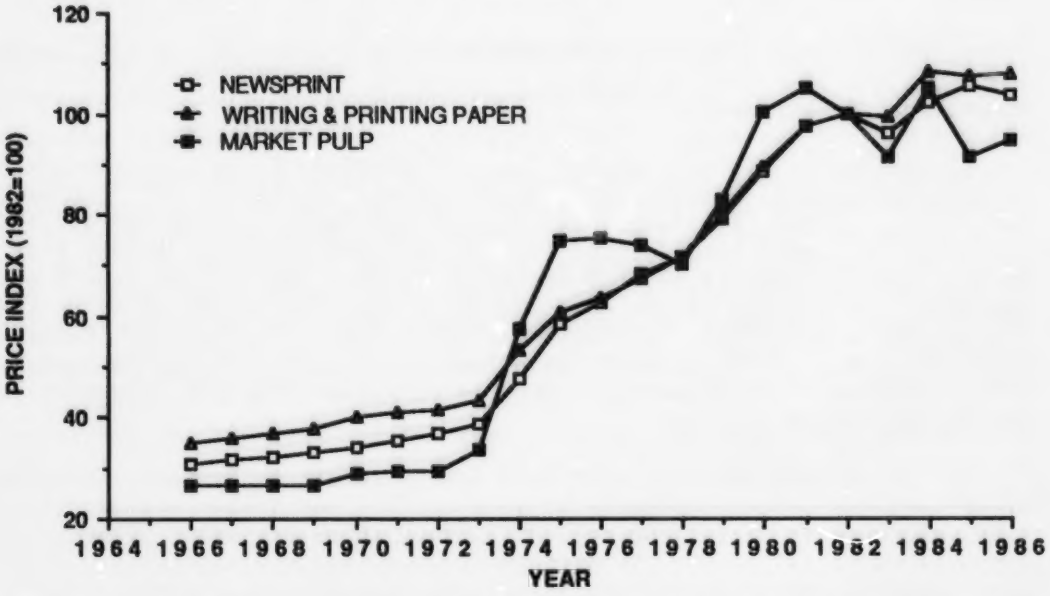

Figure 4: Price indices of newsprint, writing and printing paper, and market pulp in the American market, 1966-1986.

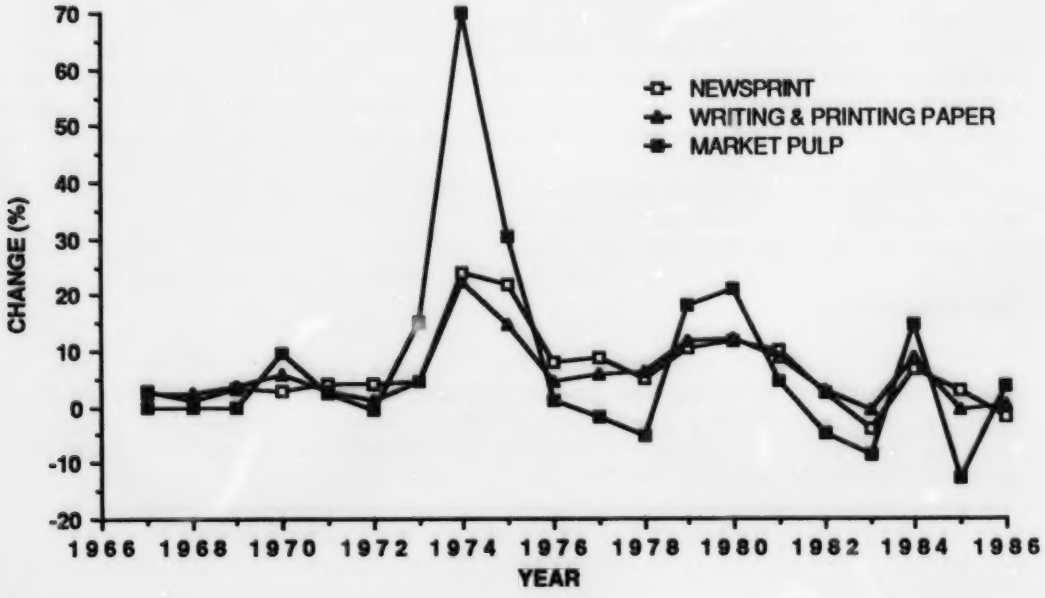

Figure 5: Percent change in price indices of newsprint, writing and printing paper, and market pulp in the American market, 1966-1986.

METHODOLOGY

Theoretical Background[1]

Analysis of the demand for a commodity in an international market involves a complex of related social, political and economic variables. A specific functional formulation cannot represent all the variables that affect the demand for a given product. This is why economists use the **ceteris paribus** concept: if all other things remain unchanged, the effects of the most important explanatory variables on the demand for a product or products can be analyzed explicitly. **Ceteris paribus**, this study deals with the effects of changes in certain important variables on the demand for Ontario's market pulp and newsprint in the United States.

To ensure that the empirical demand equations are theoretically plausible, one common procedure is to specify a particular utility function and then to derive the demand function to be estimated by means of constrained maximization. It has been proved that the constrained utility maximization approach satisfies all general restrictions (Phlips 1983). However, doubts always arise about adopting a particular specification, and a functional form that seems appropriate for the problem at hand must be specified.

The assumption underlying the analysis in this report is that a perfectly competitive market structure and a rational utility maximization by consumers prevail. This competitive market structure forces Ontario producers to act as price takers. All firms involved are forced by a long-run operation of the market to accept levels of zero economic profits (market price = minimum long-run average total cost). This condition is created by the willingness of firms to enter and to leave the industry. Under these conditions, Ontario producers strive to maximize profit.

Specifications

To estimate the demand for various products of the pulp and paper industry, several specification approaches have been tried. For example, Uutela (1987) specified global demand functions for newsprint, writing and printing paper, wrapping and packaging paper, and sack paper as:

$$(1)\quad C_{ijt} = f(C_{ij,t-1},\ Y_{jt},\ P_{ijt},\ PS_{ijt},\ D_{ijt})$$

---

[1] Appendices A and B, respectively, summarize the laws of demand and the commonly used single-equation demand models.

where: i, j, and t stand for a specific country, product, and year, respectively; C_{ijt} = per capita consumption; $C_{ij,t-1}$ = per capita consumption during the previous year; Y = real income (or GDP); P = price of the product in question; PS = price of the most direct substitute for the commodity; and D = a dummy variable expected to absorb specific variations between countries. Uutela used a log-linear formulation to estimate the functional relationship in equation (1). Buongiorno (1978) did not include a dummy variable, but used a similar specification as well as one without the lagged-consumption parameter, $C_{ij,t-1}$. He estimated simple linear equations for a dynamic model (i.e., the model with $C_{ij,t-1}$) and for a static model. Another example of demand function specification is that of Schaefer (1979), who specified demand for newsprint in the United States as:

$$(2) \quad USNPC = f(CIRC, ADV, XP, JP)$$

where USNPC = newsprint consumption in the United States, CIRC = circulation level of newspapers, ADV = advertising expenditures, XP = price of newsprint, and JP = average price of newspapers. Schaefer generated values of these explanatory variables by estimating various linear regression equations. He then estimated equation (2) by applying a simple-linear equation.

In short, just as there are numerous variables that influence the demand for a given product, there are many ways of specifying its demand. The difficulty lies in determining the explanatory variables that have significant effects on the demand for the product in question.

After several regression analyses had been run by means of the stepwise procedure, and statistical tests had been carried out, the specification given in (3) was used for estimating the demand for Ontario's newsprint in the American market:

$$(3) \quad X_t = f(P_t, PWP_t, PLP_t, Y_t, XR_t, T)$$

where X_t = the quantity of newsprint exported from Ontario to the United States; P_t, PWP_t, and PLP_t = price indices for newsprint, printing and writing paper and for market pulp in the United States, respectively; Y_t = real GDP of the United States; XR_t = exchange rate (Cdn$/US$); and T = a trend variable. The subscript "t" indicates a specific year during the period in question (1966-1986). Printing and writing paper is commonly used as the most direct substitute product in estimating the demand for newsprint. Accordingly, its price has been included in equation (3) by

other workers (see, for example, Uutela [1987] and Buongiorno [1978]). The American demand for market pulp is specified as follows:

$$(4) \quad Z_t = f(PLP_t, Y_t)$$

where Z_t = quantity of market pulp exported from Ontario to the United States, and PLP_t, Y_t and t are as explained for equation (3).

Estimation Techniques

For the purpose of this report, it was assumed that prices are determined exogenously. On the basis of this assumption, several studies have used the ordinary least squares (OLS) method of estimating single-equation demand functions. Rejection of the assumption that prices are exogenous would, in principle, require the use of simultaneous-equation estimation methods. However, it has been found that OLS applied to single-equation models is more robust against specification errors than many of the simultaneous equation models (Maddala 1977, Buongiorno 1978)[2].

To estimate the functional relationship in equation (3), a "simplified dynamic model" (with constant elasticity) that formulates the demand function as follows is used.

$$(5) \quad X_t = \alpha_0 \, e^{\theta T} \, P_t^{\beta_1} \, PWP_t^{\beta_2} \, PLP_t^{\beta_3} \, Y_t^{\eta} \, XR_t^{\rho} \, e^{ut}$$

Equation (5) can be linearized as follows:

$$(6) \quad \ln X_t = \alpha_o + \theta T + \beta_1 \ln P_t + \beta_2 \ln PWP_t + \beta_3 \ln PLP_t + \eta \ln Y_t + \rho \ln XR_t + u_t$$

It is hypothesized that the parameters β_1, β_3, and ρ would be negative. This indicates that: (a) an increase in the price of newsprint results in a reduction in the demand for newsprint; (b) newsprint and market pulp are complementary in nature [i.e., as the price of market pulp rises its market supply shifts to the right (increases), thereby encouraging newsprint production (increase in supply); this in turn applies a downward pressure on price and leads to an increase in demand]; and (c) increasing the pover of the Canadian dollar (Cdn$/US$)

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[2] Buongiorno, in estimating the worldwide demand for paper and paperboard, provides further justification for using the OLS technique.

has a negative impact on the demand for Ontario's newsprint in any foreign market. The parameter η is expected to be positive, and this reflects the fact that as real GDP of the United States increases, market demand for newsprint in that country also increases. It is not possible to predict the sign of θ: if this parameter is positive, it will imply a secular increase in demand over time; a negative sign will indicate a shift in consumer taste.

A similar formulation procedure is used to estimate the demand function for market pulp in equation (4).

RESULTS

Table 3 presents the empirical results for estimation of the demand functions. The partial coefficients are direct estimates of elasticities of demand for newsprint and market pulp with respect to the given explanatory variables in each demand equation. The own-price elasticity of newsprint is -1.45 while that of market pulp is -0.207. The cross-price elasticities of newsprint with respect to the prices of writing and printing paper and of market pulp are 2.89 and -0.32, respectively. These cross-price elasticities have the **a priori** expected signs which indicate that: (a) writing and printing paper serves as a substitute for newsprint, and (b) market pulp and newsprint are complementary products, as explained previously.

Further interpretation of the parameters is in order. Suppose that, because of the free-trade agreement between Canada and the United States, firms in both countries improve their competitive positions and increase their market supplies. As a result, a 10% yearly average decline in market prices of newsprint and market pulp in the United States can be expected. If we consider the two demand equations and vary the own-prices of newsprint and market pulp, and keep the other variables in each equation constant, the demand for these products would increase by about 14.5% and 2%, respectively. A 10% increase in the price of writing and printing paper would also result in an increase of nearly 29% in a substitution demand for newsprint. The change in market pulp price can have either negative or positive effects depending on the direction of the change. For example, the positive effect of a 10% rise in the price of market pulp is generated through an increase in its market supply, which thereby encourages newsprint production (i.e., increases supply) and consequently shifts demand for newsprint upwards by about 3.2% as a result of a possible decrease in its price. The American GDP also plays a very significant role in the process of business interaction with Canada. If, for example, the American real GDP grows by a seasonally adjusted annual rate of 3%, with the other variables fixed, demand for Ontario's newsprint and market pulp in the United States would increase by approximately 12.0% and 4.0%, respec-

Table 3. Parametric estimation results for demand functions that describe Ontario's newsprint and market pulp exports to the United States, 1966-1986. (asymptotic standard errors within parentheses)

Explanatory variable (1)	Dependent (response) variables	
	Newsprint (2)	Market pulp (3)
Intercept	-20.245 (6.879)***	4.418 (2.052)**
Price of newsprint	-1.445 (0.613)**	------
Price of printing and writing paper	2.891 (0.950)***	------
Price of market pulp	-0.317 (0.231)*	-0.207 (0.079)***
Exchange rate (Cdn$/US$)	-0.310 (0.466)	------
American real GDP	3.947 (0.763)***	1.262 (0.294)***
Trend variable	-0.149 (0.034)***	------
R^2	75%	60%
Durbin-Watson statistic	2.64	1.64

*, **, *** significant at the 90%, 95%, and 99% confidence levels, respectively

tively. The -0.31 coefficient of the exchange rate (Cdn$/US$) supports the well known observation of the negative impact of a strong Canadian dollar on Canadian exports, in this case on Ontario's newsprint exports to the United States. A 10% increase in the exchange rate would reduce newsprint exports by about 3%. The coefficient of the trend variable (-0.14) appears to be too high. However, the negative sign reflects a trend of decline in consumer taste, which is a realistic indication in view of the impact of the rapidly advancing electronic media.

The multiple coefficient of determination, R^2, has values of 76% and 60% for the newsprint and for the market pulp demand equations,

respectively. These R^2 values indicate that the variations in demand for each product are sufficiently explained by the models. However, it is possible to make some improvements, particularly on the newsprint demand model, by adding more exogenous variables. For example, the impact of advertising expenditures in the electronic media (i.e., television and radio) on the demand for newsprint can be included in the demand function specification in equation (3). An important caveat on estimation techniques is warranted, however. It would have been appropriate to compare these results with the results of other estimation techniques, such as two-stage least square (2SLS) or three-stage least square (3SLS), but this was not possible with the time and resources that were available. The main constraint has been lack of suitable econometric software. In spite of this and of possible limitations, acceptable results have been generated. Appendices D and E present some key analytical statistics from the empirical work.

Statistical Tests

In addition to the traditional t test for the significance of each partial coefficient and an F test for overall model validity, some other important tests were carried out.

In a time-series study, one attempts to detect the existence of multicollinearity and autocorrelation, which are the major violators of the assumptions of the classical model. Multicollinearity is often suspected when R^2 is very high (nearly 1.0) and when the zero-order correlations are also high; however, none or very few of the partial regression coefficients are individually statistically significant on the basis of the conventional t tests.

Results of initial estimations of the market-pulp demand equation, with five explanatory variables (the price of market pulp, PLP_t; the real GDP of the United States, Y_t; the price of newsprint, P_t; the exchange rate (Cdn$/US$), XR_t; and a trend variable, T), revealed multicollinearity among most of these explanatory variables. Since multicollinearity arises because one or more of the explanatory variables are exact or approximate linear combinations of the others, one way of detecting which explanatory variable is related to the others is to regress each explanatory variable on the others and carry out F-tests. Some econometricians refer to this procedure as an auxiliary regression method. After separate auxiliary regressions were run, it was found that the price of newsprint (P_t), the exchange rate (XR_t) and the trend variable (T) were highly correlated with each other. Consequently, these independent variables were dropped from the model and the demand

function for market pulp that is specified in equation (4) was adopted. This was found to be an easy and appropriate remedial measure for a serious multicollinearity.

The results of estimating the newsprint demand function did not show serious multicollinearity. Nonetheless, a stepwise-regression procedure was used to examine the effects of some additional available explanatory variables (e.g., American population). The procedure did not improve on the original estimation results. This and other considerations led to the adoption of the final model specified in equation (3).

Residuals from the estimates of the two demand equations did not exhibit any conspicuously systematic pattern that would indicate autocorrelation. The size of the Durbin-Watson statistic is also acceptable. Hence, no serious problem of autocorrelation was detected.

Comparison With Other Studies

The available literature shows that no study similar to this one was carried out on the demand for Ontario's market pulp and newsprint. It appears, however, that economists have studied extensively the global demand for paper and paperboard products. This section provides income and price elasticity results from various studies on the global demand for newsprint along with results of the present study.

It should be noted that strict comparisons among results from different international market studies may be misleading and sometimes confusing because of a number of differences, such as: (a) the structure and size of the marketplace; (b) the methods of deflation; (c) exchange rate manipulation; (d) explanatory variables; (e) functional formulation and estimation techniques; and (f) the period of observation, which varies in terms of both the length of the period (sample size) and the economic climate during that period.

Table 4 summarizes income and price elasticities of demand for newsprint. The global studies classified countries into three categories on the basis of per capita GDP: (i) low-income (<US$1000), (ii) middle-income (US$1000-3000), and (iii) high-income (>US$3000). The results reported in Table 4 are for the middle-income countries. Uutela (1987) concluded that income elasticity tended to decrease over time and with increasing per capita GDP. However, an argument against this conclusion is valid. Because of the availability of various substitutes for newspapers, one expects higher elasticity rates for the developed (higher-income) countries. The highest income elasticity was measured for the per capita GDP group US$1000-3000 (i.e., the middle-income countries). With the exception of the value of -2.60, reported by Uutela (1987), all studies indicate that newsprint is price-inelastic,

Table 4. Estimates of income-, own- and cross-price elasticities of demand for newsprint, from different studies.

Investigator and scope of study[a]	Explanatory variables[b]	Observation period	Elasticities		
			Income	Own-price	Cross-price[c]
Buongiorno (1978) Global demand	Y_t, C_{t-1}, P_t, PWP_t	1963-1973	1.00	-0.80	0.40
Wibe (1984) Global demand	Y_t, P_t, T	1970-1979	1.20	-2.60	----
JP/Suhonen (1984) Global demand	Y_t, C_{t-1}, P_t, PWP_t	1965-1980	1.20	-0.70	0.10
Uutela (1987) Global demand	Y_t, C_{t-1}, P_t, PWP_t	1965-1980	1.19	-0.73	0.02
Uutela (1987)	Y_t, C_{t-1}, P_t, PWP_t	1965-1980	0.75	-0.45	0.36
Present study	Y_t, XR_t, P_t, PWP_t, PLP_t, T	1966-1986	3.94	-1.45	2.89

[a] The results of each study other than the present one are taken from Uutela (1987).
[b] The variable C_{t-1} represents the annually lagged consumption of newsprint. Other variables are explained in the text.
[c] Cross-price elasticity is reported with respect to PWP_t (the price index of printing and writing paper).

Uutela (1987), all studies indicate that newsprint is price-inelastic, but income-elastic at the global level. Although income elasticity and cross-price elasticity with respect to writing and printing paper seem large, the present study provides an acceptable own-price elasticity of demand for newsprint in the American market. The own- and cross-price elasticities of the global and the EEC-region studies have very low values. Such elasticities for well developed economies (e.g., the EEC) should be treated with great caution during a process of policy formulation.

It is obvious, therefore, that statistical estimates do not provide quick-fix solutions. Personal judgment, on the basis of experience and of a clear understanding of the theoretical background of the experiment, is required to draw credible conclusions. The information in Table 4 is more useful for comparing the various specifications of demand models than for comparing the estimation results strictly.

CONCLUSIONS

Annual trends in the data indicate that Ontario's newsprint and market pulp exports to the United States over the 21-year period from 1966 to 1986 increased at annual average rates of 0.80% and 2.73%, respectively. The pattern of these export growth rates tends to have the same direction as the growth of the American real GDP, which grew at an annual average rate of 2.53% (Table 1 and Fig. 3). Similarly, the price indices of market pulp, newsprint, and writing and printing paper rose at average rates of 6.44%, 7.80% and 5.92%, respectively. A number of national and international issues were addressed in an attempt to explain the cyclical movements of the data.

A "simplified dynamic" model and a static model were used to estimate the demand functions of newsprint and market pulp, respectively. Both models produced results that conform with economic theory (Table 3). The partial coefficients, which are direct estimates of elasticities of demand for newsprint and market pulp with respect to each explanatory variable in each model, have the correct arithmetic signs and reasonably acceptable sizes. Newsprint has approximately -1.45 own-price elasticity, 3.95 income elasticity, and 2.89 and -0.32 cross-price elasticities with respect to the prices of writing and printing paper and of market pulp, respectively. Although it is not very significant statistically, the negative impact of increasing purchasing power of the Canadian dollar on American demand for Ontario's newsprint, **ceteris paribus**, is illustrated by the -0.31 elasticity value. The own-price and income elasticities of market pulp are -0.21 and 1.26, respectively. The coefficient of the trend variable reflects a decline in consumer taste over time, indicating the impact of the rapidly growing electronic media.

Several conclusions can be drawn from the results of the analyses carried out in the present report:

(i) Despite the short period covered by the available data and the lack of average national delivered-price statistics, the methodology used for this study has provided elasticity estimates that conform with theoretical expectations.

(ii) Demand for newsprint is price-elastic whereas that for market pulp is inelastic. Both newsprint and market pulp are income-elastic.

(iii) Over the 21-year period from 1966 to 1986, it appears that the rapid fluctuations of exports of the two products are strongly correlated with a number of national and international issues, such as the 1974-1975 recession in the American economy and the 1973-1974 and 1979-1980 worldwide "energy shocks".

(iv) If the strength of the Canadian dollar increases significantly with respect to the American dollar, Canadian exports to the United States will decline. Ontario's newsprint and market pulp, which are exempt from tariffs on entry to the United States, can be influenced easily by monetary and fiscal policies of both American and Canadian governments. Hence, Ontario producers need to investigate the exchange rate between the two currencies and the price elasticities of demand before substantially increasing prices and/or outputs.

(v) If American economic growth continues at a modest rate and other competing suppliers do not increase their market supplies significantly, there may be opportunities in the American market to increase prices for newsprint and market pulp. However, it should be kept in mind that demand for newsprint is highly price-elastic. It is advisable to assess the overall market situation and the price of the major substitute commodity, writing and printing paper, before a decision is made to increase prices.

(vi) A moderate increase in the price of writing and printing paper in the American market would result in a considerable increase in the demand for newsprint (the substitution effect).

(vii) A slight increase in the real per capita GDP of the United States has a very significant positive impact on the demands for both newsprint and market pulp (the income effect).

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APPENDICES

APPENDIX A: A SUMMARY OF THE ESSENTIALS OF THE LAWS OF DEMAND

Because of the diverse nature of their daily duties, public servants and other professionals tend to forget much of the economics theory they learned in school. This appendix provides a summary of the essentials of the laws of demand. Its objective is to refresh the memory of such people.

In general, the behavior of a consumer is examined in four market situations:
(a) change in income only;
(b) change in own-price of a given commodity only;
(c) change in prices of substitutes and complements; and
(d) a simultaneous change in all prices (including own-price) and income.

A demand function must possess four properties:

(i) Demand functions are homogeneous and of degree zero in prices and income; that is, an equiproportional change in both prices and income has no effect on the demand for a commodity. In other words, money illusion (see Glossary, Appendix C) is ruled out. To illustrate this, a general demand function is:

$$(A.1) \qquad X_i = f(P_1, \ldots, P_n, m)$$

where: X_i = consumption of a given commodity,
P_i = market price, and
m = money income of the consumer.

By means of Euler's theorem[3]:

$$(A.2) \qquad dx_i = 0 = \sum \left(\frac{\partial X_i}{\partial P_j}\right) P_j + \left(\frac{\partial x_i}{\partial m}\right) m$$

Coefficients have been placed within parentheses for clarity.

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[3]The proof of this theorem is straightforward and is available in most intermediate microeconomics textbooks. For details, refer to Chiang (1984).

Dividing all terms in equation (A.2) by X_i gives:

$$\Sigma\varepsilon_{ij}+\eta_{ij} = 0 \qquad (A.3)$$

Where: ε_{ij} = price elasticity

η_{im} = income elasticity

(ii) The weighted average of income elasticities of demand is unity. (The weights are the relative shares of total expenditure in each good.) This condition comes from the budget-constraint identity (i.e., the idea that the sum of expenditures cannot exceed money income).

If $\Sigma P_i X_i = m$, with utility and prices constant, the total change in income is:

$$\sum P_i \left(\frac{\partial x_i}{\partial m}\right) = 1 \qquad (A.4)$$

That is,

$$\sum \left(\frac{P_i X_i}{m}\right) * \left(\frac{\partial x_i}{\partial m}\right) * \left(\frac{m}{X_i}\right) = 1 \qquad (A.5)$$

Thus,

$$\Sigma s_i * \eta_{im} = 1. \qquad (A.6)$$

Where: s_i = share of commodity i in total expenditure

η_{im} = elasticity of demand for commodity i with respect to money income, m.

The condition described from (A.4) to (A.6) is referred to as the "adding-up property" of a demand function.

(iii) The most important of the laws of demand is the downward-sloping nature of a compensated demand curve (Layard and Walters 1978). Because of the property of homogeneity of degree zero, an increase in P_i simultaneously adjusted by an increase in income (to keep utility constant) causes a reduction in the demand for X_i by a small margin,

say x_i. This situation is usually referred to as a negative substitution effect. That is, the income effect of a unit increase in P_i is:

$$(A.7) \quad (-x_i)\left(\frac{\partial x_i}{\partial m}\right)$$

In general, this means that:

$$(A.8) \quad \left(\frac{\partial x_i}{\partial P_j}\right) = \left(\frac{\partial x_i}{\partial P_j}\right)_{u=const.} - X_j\left(\frac{\partial x_i}{\partial m}\right)$$

Equation (A.8) is known as the Hicks-Slutsky decomposition (Layard and Walters 1978) and implies that:

$$(A.9) \quad \left(\frac{\partial x_i}{\partial P_j}\right)\frac{P_j}{X_i} = \left(\frac{\partial x_i}{\partial P_j}\right)\frac{P_j}{X_i} - \frac{P_j X_j}{m}\left(\frac{\partial x_i}{\partial m}\right)\frac{m}{X_i}$$

Therefore,

$$(A.10) \quad \varepsilon_{ij} = \varepsilon^*_{ij} - s_j * \eta_{im}$$

where ε^*_{ij} indicates the income-compensation effect. The other terms are described under equation (A.3).

(iv) If utility is constant, the symmetry of cross-substitution effects of an ordinary demand function is:

$$(A.11) \quad \left(\frac{\partial x_i}{\partial P_j}\right) = \left(\frac{\partial x_j}{\partial P_i}\right)$$

The relevant Slutsky equation (Layard and Walters 1978) holds for each of these terms; hence, an ordinary demand curve has the property of:

$$(A.12) \quad \left(\frac{\partial x_i}{\partial P_j}\right) + X_j\left(\frac{\partial x_i}{\partial m}\right) = \left(\frac{\partial x_j}{\partial P_i}\right) + X_i\left(\frac{\partial x_j}{\partial m}\right)$$

For any pair of goods, i and j:

$\frac{\partial x_i}{\partial P_j} > 0$ implies that i and j are substitutes; and

$\frac{\partial x_i}{\partial P_j} < 0$ implies that i and j are complements.

APPENDIX B: A REVIEW OF SOME COMMONLY USED SINGLE-EQUATION DEMAND MODELS

There are several single equations and systems of equations that can be used to estimate a demand function. Intriligator (1978) describes a number of models that have been widely used for estimating the demand for various commodities. The simplest functional form for a single demand equation is the linear demand equation. For commodity i, a linear demand equation is written as:

$$(B.1) \quad X_{it} = \alpha_0 + \beta_i P_{it} + \beta_j P_j + \eta Y_{dt} + u_{it}$$

where X_{it} = per capita consumption of commodity i in year t; P_{it} and P_{jt} = prices of commodity i and commodity j, respectively; Y_{dt} = personal disposable income; and u_{it} = a disturbance term. A second functional form is the semilogarithmic demand function, which is written as:

$$(B.2) \quad X_i = \alpha_0 + \beta_i \ln P_i + \beta_j \ln P_j + \eta \ln Y_d + u_i$$

where ln stands for the natural logarithm.

A third functional form, one that has been widely used, is the log-linear (or constant-elasticity) form. It formulates a demand function as:

$$(B.3) \quad X_i = \alpha_0 \, P_{it}^{\beta i} \, P_{jt}^{\beta j} \, Y_{dt}^{\eta} \, e^{uit}$$

Taking the logarithm of both sides of (B.3) gives:

$$(B.4) \quad \ln X_{it} = \alpha_0 + \beta_i \ln P_{it} + \beta_j \ln P_{jt} + \eta \ln Y_{dt} + u_{it}$$

where β_i, β_j, and η are direct estimates of own-price, cross-price, and income elasticities, respectively. The own-price elasticity of good i is derived as:

$$(B.5) \quad \varepsilon_{ii} = \beta_i = \frac{\partial \ln X_{it}}{\partial \ln P_{it}} = \frac{\partial x_{it}}{\partial p_{it}} \frac{P_{it}}{X_i}$$

and the cross-price elasticity of good i with respect to the price of good j is

$$(B.6)\quad \varepsilon_{ij} = \beta_j = \frac{\partial \ln X_{it}}{\partial \ln P_{jt}} = \frac{\partial x_{it}}{\partial p_{jt}} \frac{P_{jt}}{X_{it}}$$

Similarly, the income elasticity of demand for good i is:

$$(B.7)\quad \varepsilon_{iy} = \eta = \frac{\partial \ln X_{it}}{\partial \ln Y_{dt}} = \frac{\partial x_i}{\partial y_{dt}} \frac{Y_{dt}}{X_{it}} .$$

Recent studies indicate that a log-linear model, which includes a trend variable, gives more credible results than the models described above. It is formulated as:

$$(B.8)\quad X_i = \alpha_0 \, e^{\theta T} \, P_{it}^{\beta i} \, P_{jt}^{\beta j} \, Y_{dt}^{\eta} \, e^{uit}$$

That is,

$$(B.9)\quad \ln X_{it} = \alpha_0 + \theta T + \beta_i \ln P_{it} + \beta_j \ln P_{jt} + \eta \ln Y_{dt} + u_{it}$$

Whereas the models in (B.1), (B.2), and (B.3) are static, Uutela (1987) describes the model in (B.8) as a "simplified dynamic" function. He used this model in his study of the global demand for paper and paperboard. The trend variable (T), which is measured in years, is a "catch-all" variable whose coefficient (θ) indicates the direction and the rate of change of demand with respect to time.

Another version of model (B.3), which includes a lagged endogenous variable to the righthand side of the equation (as an explanatory variable), is often discussed in the literature and sometimes used in empirical work. It is specified as:

$$(B.10)\quad X_{it} = \alpha_0 \, X_{i,t-1}^{\lambda i} \, P_{it}^{\beta i} \, P_{jt}^{\beta j} \, Y_{dt}^{\eta} \, e^{uit}$$

where $X_{i,t-1}$ = per capita consumption of "i" during a previous year ("t-1"). Because it gives importance to variations in per capita consumption over time, this model is referred to as dynamic. The introduction of $X_{i,t-1}$ is because of the belief that the consumer's current spending behavior is influenced, among other things, by expenditures during the previous year.

APPENDIX C: GLOSSARY OF FREQUENTLY USED TERMS

Autocorrelation. If the error terms in different observations of the variables (in time-series data) are either positively or negatively correlated, autocorrelation exists: this means that there is a serial correlation of error terms. This is one possible violation of the assumptions of the classical regression model.

Cross-price elasticity. The responsiveness of the demand for a commodity to a change in price of another commodity. In the case of this study, for example, the cross-price elasticity of demand for newsprint with respect to the price of writing and printing paper is 2.799.

Econometrics. The application of mathematical and statistical techniques to economic problems; the measurement of the influences of variables on a given socio-economic system. Econometric studies proceed by formulating a mathematical model. Then, with the best data that are available, statistical methods are used to obtain estimates of the parameters in the model. Methods of statistical inference are then used to decide whether the hypotheses that underlie the model must be accepted or rejected.

Economic efficiency. The optimal combination of inputs in the production of a given commodity or commodities over a period of time. Economic theory suggests that optimal combination of inputs is attained at a point where an **isoquant** is tangent to an **isocost** line. (An **isoquant** is a line that represents all possible combinations of inputs, such as capital and labor, that produce a given level of output; an **isocost** is a line that represents all combinations of inputs at a given level of total cost.) Economic efficiency is also commonly referred to as the least-cost combination of inputs.

Endogenous variable. A variable whose value is determined by forces that operate within the model under consideration. In this study, the estimated quantities of newsprint and market pulp demanded are the endogeneous variables; their values are functions of the changes in the exogenous variables (see below): price indices, the real GDP of the United States, the exchange rate (Cdn$/US$), and the trend variable.

Exogenous variable. A variable that is determined by forces working outside the model. It plays a determining role in explaining the changes in the endogenous variable (see above).

Euler's Theorem. This theorem is named after its developer, the Swiss mathematician, Leonhard Euler (1707-1783), and states that factors of production (i.e., land, labor, capital) will each earn an income equal to the marginal product of each in a perfectly competitive market structure. The theory is also widely applied in aspects of economics other than production. In consumer theory, for example, if a demand function is stated as $Q = f(P_x, P_y, I)$ with a degree of homogeneity ε, this implies that:

$$f(\lambda P_x, \lambda P_y, \lambda I) = \lambda^{\varepsilon} f(P_x, P_y, I) = \lambda^{\varepsilon} Q$$

Then, in the case of homogeneity of degree zero (i.e., $\varepsilon = 0$), total differentiation gives:

$$\frac{\partial Q}{\partial P_x} P_x + \frac{\partial Q}{\partial P_y} P_y = 0$$

where P_x, and P_y are the prices of commodities X and Y, respectively, and I stands for income.

Fiscal policy. Part of government policy that deals with raising public revenues through taxation and other means and deciding on the level and pattern of expenditure.

Free trade. The free flow of goods and services across international borders. Governments neither restrict nor encourage the flow of trade once a free trade agreement is constitutionalized.

Monetary policy. Part of economic policy that regulates the level of money supply (liquidity) in the economy in order to achieve some desired policy objectives, such as the control of inflation, an improvement in the balance of payments, and growth in the gross national product.

Money illusion. Propensity to respond to changes in money income without considering its "real value". Suppose that individual A's income doubles but that prices double simultaneously. If A's tendency to buy more goods increases, then A has failed to realize that the increased income has been compensated for exactly by the rise in prices, which means that the apparent increase in buying power is illusory.

Multicollinearity. This term originated with Ragnar Frish (Gujarati 1978). It means that a linear relationship exists among some or all explanatory variables of a regression model. The practical consequences of multicollinearity include: (a) a tendency for standard errors to increase as the degree of collinearity among variables increases; (b) the confidence intervals for relevant population parameters tend to be larger as a result of large standard errors; and (c) by virtue of (b), in cases of high multicollinearity, there is the possibility of accepting a false hypothesis (i.e., a type II error), even though data seem compatible.

Perfect competition. A market structure in which the following assumptions hold:

(a) The number of buyers and sellers is large.
(b) There is a free flow of market information.
(c) Actions taken by an individual economic agent (a buyer or a seller) have no impact on market forces; hence, each must act as a price taker.
(d) Firms are free to enter and exit from the market.
(e) The goods being studied are homogeneous.

Time series. The values of a variable observed over several consecutive periods.

APPENDIX D: SOME KEY ANALYTICAL STATISTICS ON THE ESTIMATION OF THE DEMAND FOR ONTARIO'S NEWSPRINT IN THE UNITED STATES

DEPENDANT VARIABLE: LNQNP (natural log of the quantity of newsprint)

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>P
MODEL	6	0.16345185	0.02724198	7.460	0.001
ERROR	14	0.05112524	0.00365180		
C TOTAL	20	0.2145771			

ROOT MSE	0.06043015	R-SQUARE	0.761
DEP MEAN	14.23561	ADJ R-SQ	0.659
C.V.	0.424499		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR HO: PARAMETER=0	PROB >|T|
INTERCEPT	1	-20.2457	6.87961769	-2.943	0.010
LNPINP	1	-1.445	0.61338116	-2.356	0.033
LNPIWP	1	2.89158783	0.95034954	3.043	0.008
LNPIPLP	1	-0.317133	0.23127403	-1.371	0.191
LNXR	1	-0.310234	0.46611906	-0.666	0.516
LNY	1	3.94723403	0.76313167	5.172	0.000
T	1	-0.149596	0.03467679	-4.314	0.000

CORRELATION OF ESTIMATES (CORRELATION MATRIX)

	INTERCEPT	LNPINP	LNPIWP	LNPIPLP	LNXR	LNY	T
INTERCEPT	1.0000	0.4236	-0.6870	0.3499	0.5380	-0.9812	0.939
LNPINP	0.4236	1.0000	-0.7605	-0.2388	0.1412	-0.3887	0.395
LNPIWP	-0.6870	-0.7605	1.0000	-0.4156	-0.6716	0.5635	-0.782
LNPIPLP	0.3499	-0.2388	-0.4156	1.0000	0.8228	-0.2210	0.486
LNXR	0.5380	0.1412	-0.6716	0.8228	1.0000	-0.4078	0.623
LNY	-0.9812	-0.3887	0.5635	-0.2210	-0.4078	1.0000	-0.864
T	0.9391	0.3957	-0.7822	0.4861	0.6234	-0.8645	1.000

PREDICTED AND ACTUAL VALUES

OBS	ACTUAL	PREDICTED VALUE	RESIDUALS
1	14.2820	14.2448	.037130
2	14.2592	14.2293	.029897
3	14.2300	14.2896	-0.0595
4	14.3154	14.2888	.026564
5	14.2188	14.2282	-.00932
6	14.1663	14.2068	-.04044
7	14.1714	14.2223	-.05085
8	14.3000	14.2719	.028109
9	14.3244	14.2025	0.121
10	13.9145	14.0239	-.10946
11	14.0744	14.0889	-.01455
12	14.1935	14.1419	.051610
13	14.2711	14.2945	-.02340
14	14.3293	14.3421	-.01280
15	14.3055	14.2938	.011673
16	14.2696	14.3011	-.03150
17	14.1224	14.0984	.023951
18	14.2286	14.1683	.060333
19	14.3241	14.3765	-.05243
20	14.3464	14.3187	.027689
21	14.3010	14.3154	-.01446

SUM OF RESIDUALS -1.19904E-1
SUM OF SQUARED RESIDUALS 0.0511252

DURBIN-WATSON D 2.60
(FOR NUMBER OF OBS.) 21
1ST ORDER AUTOCORRELATION -0.31

APPENDIX E: SOME KEY ANALYTICAL STATISTICS ON THE ESTIMATION OF DEMAND FOR ONTARIO'S MARKET PULP IN THE UNITED STATES

DEPENDENT VARIABLE: LNQPLP (natural log of the quantity of market pulp)

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>P
MODEL	2	0.20523990	0.10261995	13.673	0.000
ERROR	18	0.13509938	0.00750552		
C TOTAL	20	0.3403392			

ROOT MSE	0.08663441	R-SQUARE	0.603
DEP MEAN	13.61483	ADJ R-SQ	0.558
C.V.	0.63632		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR HO: PARAMETER=0	PROB >|T|
INTERCEPT	1	4.41872082	2.05282001	2.153	0.045
LNPIPLP	1	-0.20736	0.07977608	-2.599	0.018
LNY	1	1.26222452	0.29425504	4.290	0.000

CORRELATION OF ESTIMATES

(CORRELATION MATRIX)

	INTERCEPT	LNPIPLP	LNY
INTERCEPT	1.0000	0.8734	-0.997
LNPIPLP	0.8734	1.0000	-0.904
LNY	-0.9977	-0.9040	1.000

PREDICTED AND ACTUAL VALUES

OBS	ACTUAL	PREDICTED VALUE	RESIDUAL
1	13.3999	13.4500	-.05006
2	13.5196	13.4855	.034176
3	13.5814	13.5364	.044952
4	13.6844	13.5674	0.117
5	13.5918	13.5449	.046872
6	13.5495	13.5737	-.02422
7	13.5737	13.6355	-.06175
8	13.5969	13.6671	-0.0701
9	13.6180	13.5483	.069639
10	13.3659	13.4807	-0.1148
11	13.3670	13.5380	-0.1710
12	13.6251	13.5979	0.02724
13	13.5756	13.6730	-.09743
14	13.7040	13.6647	.039269
15	13.7133	13.6232	.090065
16	13.7313	13.6388	0.09248
17	13.5976	13.6170	-.01943
18	13.7858	13.6818	0.104
19	13.8149	13.7391	.075818
20	13.7051	13.8084	-.10325
21	13.8106	13.8400	-.02937

SUM OF RESIDUALS	-5.55112E-1
SUM OF SQUARED RESIDUALS	0.135099
DURBIN-WATSON D	1.64
(FOR NUMBER OF OBS.)	21
1ST ORDER AUTOCORRELATION	0.16